Remarks/Arguments

Reconsideration of this application is requested.

Extension of Time

A request for a three month extension of the period for response to the Office Action mailed on October 25, 2004 is enclosed. The extended period for response expires on April 25, 2005.

Claim Status

Claims 1, 2, 6-8 and 22-30 were previously presented. Claims 7, 22, 25, 27 and 30 are amended, and claims 36-38 are added. Accordingly, claims 1, 2, 6-8, 22-30 and 36-38 are now pending.

Claim Rejections – 35 USC 103

Claims 1, 2, 6-8 and 22-25 are rejected under 35 USC 103(a) as obvious over Carlson et al. (US 5,421,957) ("Carlson") in view of Laxman et al. (US 5,874,368) ("Laxman"). Claims 26-30 are rejected under 35 USC 103(a) as obvious over Carlson in view of Laxman and further in view of Nagashima (US 5,129,958). For the reasons set forth below, applicant traverses these rejections.

Silicon nitride formed using BTBAS and NH_3 has a stronger film stress and a greater film shrinkage as compared to a general silicon nitride formed using SiH_4 and NH_3 or using SiH_2Cl_2(DCS) and NH_3 (see applicants' specification, page 2, line 11 to page 3, line 9, and Figs. 4 and 5). Specifically, the general silicon nitride has a film stress of about 1GPa, while silicon nitride formed using BTBAS and NH_3 has a film stress of about 2 GPa (see Fig. 5). That is, silicon nitride formed using BTBAS and NH_3 has about twice the film stress as the general silicon nitride. The general silicon nitride has a film shrinkage rate of about 1%, whereas silicon nitride formed using BTBAS and NH_3 has a film shrinkage rate of about 9% (See Fig. 4). That is, silicon nitride formed using BTBAS and NH_3 has about nine times as much film shrinkage rate as the general silicon nitride.

For these reasons, the ways in which the silicon nitride comes off of a reaction container, and a critical thickness at which microcracks are generated in the silicon

nitride formed on the reaction container and particles are generated on the wafer, are different between these two kinds of silicon nitride. In the case of the silicon nitride formed using BTBAS and NH_3, if a thickness of the silicon nitride reaches 4,000 Å, microcracks are generated in the silicon nitride formed on the reaction container, resulting in generation of particles.

Consequently, in the case of silicon nitride formed using BTBAS and NH_3, 4000Å is the critical film thickness at which microcracks are generated in the silicon nitride to generate particles. In this manner, silicon nitride formed using BTBAS and NH_3 starts to come off at an extremely small thickness compared to the general silicon nitride film, That is, silicon nitride formed using BTBAS and NH_3 begins to come off at a much smaller thickness than the thickness that an ordinary person of skill in the art would expect microcracks to be generated in general silicon nitride film.

The present invention is based upon these findings and is specific to a process of forming silicon nitride, using BTBAS and NH_3, which has completely different characteristics from the general silicon nitride formed using SiH_4 and NH_3 or using SiH_2Cl_2(DCS) and NH_3. Each of independent claims 1, 22 and 27 requires removal of the silicon nitride formed in said reaction container before the silicon nitride reaches a thickness of 4,000 Å. The criticality of this thickness and the unexpected results associated therewith are clearly demonstrated by the specification, and are not disclosed or suggested by the prior art of record.

Carlson recognizes that if a film having a sufficient thickness in the range of 1 to 5 micrometers (10,000Å -50,000Å) builds up, it can contaminate the process. That is, Carlson recognizes that the range of less than 1 micrometer (10,000Å) is a film thickness range which does not cause process contamination. However, the range of less than 1 micrometer (10,000Å), which, according to Carlson, is the film thickness range not causing process contamination, includes a range of more than or equal to 4,000 Å , which range generates microcracks in the present invention. Thus, if Carlson is applied to silicon nitride formation using BTBAS and NH_3, when a cumulative thickness reaches 4,000Å, *there is no motivation to remove the film since*

according to Carlson there is no process contamination until the range of 1 to 5 micrometers (10,000Å -50,000Å) is reached. Thus, following the teachings of Carlson, particles will be generated, with the result being that cleaning is not effected before particles are generated. This result runs contrary to the teachings of the present invention, and is due to the fact that Carlson does not consider forming silicon nitride using BTBAS and NH_3, which has greatly different characteristics from the general silicon nitride formed using SiH_4 and NH_3 or using SiH_2Cl_2(DCS) and NH_3.

The Action asserts that "...Carlson shows several tests removing silicon nitride of less than 4,000 angstroms (see Table I, II, col. 6, lines 1-69, col. 7-8)". Applicant respectfully disagrees. Table I, II, col. 6, lines 1-69, col. 7-8, describes only cleaning time (min) and Etch Rate (Å/min), and thus teaches only an *etching amount* of films of silicon nitride. Contrary to this disclosure, the critical film thickness of 4000Å at which microcracks are generated in the silicon nitride to generate particles is a *thickness of a film* which has been deposited in the reaction container, not an etching amount. In any event, as described above, Carlson fails to disclose or suggest that the critical deposited film thickness is 4000Å.

The ancillary references Laxman and Nagashima do not remedy the deficiencies of Carlson. Thus, claims 1, 2, 6-8 and 22-30 are not rendered obvious by the references of record, and the rejections under 35 USC 103(a) should be withdrawn.

Claim Amendments/New Claims

Claim 7 is amended to depend from claim 6, rather than claim 1. Claim 22 is amended to better define the subject matter of the invention. Claim 25 is amended to depend from claim 24, rather than claim 22. Claim 27 is amended to recite the critical thickness of 4000 Å. Claim 30 is amended to depend from claim 29, rather than claim 27. New claims 36-38 are added to further define the invention.

Conclusion

This application is now in condition for allowance. The Examiner is invited to telephone the undersigned to resolve any issues that remain after entry of this

amendment. Any fees due with this response may be charged to our Deposit Account No. 50-1314.

Respectfully submitted,
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